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Guidance Documents Relating to Landfills and Contaminants

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GUIDANCE DOCUMENTS RELATING TO LANDFILLS AND CONTAMINANTS

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16. ABSTRACT

The Environmental Protection Agency is developing and updating a series of Technical Guidance Documents to provide best engineering control technology to meet the needs of the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), respectively. These documents are the compilation of the research efforts to date relating to containment of pollutants from waste disposal to the land as relates to residuals management. The specific areas of research being conducted under the RCRA land disposal program relates to laboratory, pilot and field validation studies in cover systems, waste leaching and solidification, liner systems and disposal facility evaluation. The specific areas of research being conducted under the CERCLA uncontrolled waste sites (Superfund) program relate to in situ treatment, solidification/stabilization for treating hazardous waste, combustion technologies, best demonstrated available technology (BDAT), on-site treatment technologies, emerging biosystems, expert systems, personnel health protection equipment, and site and situation assessment. The Guidance Documents are intended to assist both the regulated community and the permitting authorities, as well as the Program Offices, and Regions, as well as the states and other interested parties, with the latest information relevant to waste management.

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GUIDANCE DOCUMENTS RELATING TO LANDFILLS AND CONTAMINATED SITES

Norbert B. Schomaker
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1. Introduction

Land disposal of hazardous waste is subject to requirements in Subtitle C of the Resource Conservation and Recovery Act (RCRA) of 1976 and in the Hazardous and Solid Waste Amendments of 1984, requiring that treatment, storage or disposal of hazardous waste be carried out in accordance with the RCRA regulations. Owners and operators of new facilities must apply for and receive a RCRA permit before beginning operation of such a facility.

The clean up or containment technology associated with pollutant release from existing uncontrolled hazardous waste sites is subject to the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund) and the Superfund Amendments and Reauthorization Act of 1986 (SARA) which requires the evaluation of various control technologies.

To meet the Control Technology aspects of RCRA and CERCLA as related to Land Disposal Facilities, the research program has relied heavily upon the containment

aspects of the wastes at the facility or site. The containment aspects of waste disposal onto the land need to address the development of performance and operational standards for new waste disposal facilities (RCRA sites) and the destruction, treatment, or containment of pollutants emanating from existing waste disposal facilities (CERCLA sites). The control technology research approach being pursued by the USEPA is to develop and improved data base so that current waste disposal practices can be upgraded by developing proper site selection criteria and control technology for the establishment of new waste disposal facilities, and to develop improved destruction, treatment and containment technology for existing waste disposal sites by minimizing pollutant generation and release to the environment.

The development of proper control technology for new (RCRA) waste disposal facilities will combine information from laboratory, pilot and field validation studies in the research areas of cover systems, waste leaching, solidification, liner systems, and disposal facility evaluation. Incorporated throughout the research for development of control technology for new waste disposal facilities is a continuous technology transfer and assistance program of activity for the program office and regional offices and user communities. The Technical Guidance Documents are considered to be primary documents for transferring current RCRA control technologies to the user. These documents are being developed and published to assist the permit applicants and permit review officials to assure that the latest containment facility technology is being utilized.

The development of proper destruction, treatment and containment technology to upgrade existing (CERCLA) waste disposal facilities will combine information from the above described program for new waste disposal facilities along with pilot and field validation programs in the research areas of *in situ* treatment, solidification/stabilization for treating hazardous waste, combustion technologies, best demonstrated available technology (BDAT), on-site treatment technologies, emerging biosystems, expert systems, personnel health protection equipment, and site and situation assessment.

2. Technical Guidance Documents for Landfills

Twelve (12) guidance documents have been completed to date. These documents relate primarily to landfills but some of the documents relate to surface impoundments. A listing of these documents is shown below, along with a brief description, and the NTIS publication number.

2.1 Evaluating Cover Systems for Solid and Hazardous Waste

A critical part of designing, constructing, and maintaining an effective cover over solid and hazardous waste sites is the evaluation of engineering plans for landfill construction. All aspects of covers are addressed in detail to allow for a complete evaluation of the entire cover system. The document describes current technology for landfill covers in eleven sequential procedures across three broad ares: data examination, evaluation process and post-closure plan. Data examination utilizes seven (7) steps to discuss test data review procedure, topographical data review and climatological data review procedures. The evaluation process utilizes twenty-five (25) steps which include placement, vegetation, drainage, cover composition, thickness and configuration. The post-

closure aspects utilize seven (7) steps to include maintenance and contingency plan evaluation procedures. There are thirty-nine (39) specific steps regarding the preceding factors which are recommended to be followed in evaluating a permit for a cover for hazardous waste. This document is identified as NTIS number PB 87-154894.*

2.2 Final Covers on Hazardous Waste Landfills and Surface Impoundments

This guidance document recommends a multilayer final cover design for hazardous waste landfills that includes three principal layers: (1) a top layer of vegetation or rocky material on at least 24 inches of soil; (2) a soil drainage layer at least 12 inches thick with a minimum hydraulic conductivity of $1x10^{-2}$ cm/sec, or a geosynthetic drainage layer with similar flow capacity; and (3) a two-component low-permeability bottom layer of flexible membrane liners (FML) (at least 20 mils thick) on compacted soil at least 24 inches thick. Other layers are optional. For example, a biobarrier layer of cobbles may be placed above the drainage layer to prevent the intrusion of roots and burrowing animals. A gas vent layer may be installed between the waste and low-permeability layer. Filter layers of soil or geosynthetic materials may be placed between other layers to prevent clogging of the underlying layer. A geosynthetic (e.g., geotextile) protective layer may be included atop the FML to prevent construction damage or puncture by coarser soil particles. This document is expected to be available from NTIS in November, 1989.

2.3 Landfill and Surface Impoundment Performance Evaluation

The evaluation of leachate collection systems using compacted clay or synthetic liners to determine how much leachate will be collected and how much will seep through the liner into underlying soils is presented. The adequacy of sand and gravel drain layers, slope, and pipe spacing is also discussed. The document has allowed for the widely varied technical backgrounds of the audience by presenting the mathematics involved in the equations. Thus, any evaluator can take full advantage of the document up to the level of his own mathematical proficiency. This document is identified as NTIS number PB 81-166357.*

2.4 Hydrologic Evaluation of Landfill Performance (HELP) Model

The HELP Model is a modification of the original waste disposal site hydrologic model entitled, "Hydrologic Simulation of Solid Waste Disposal Sites." This update has incorporated the two-dimensional aspects of landfill cover leachate collection system. OSW published this document (SW-84-009 and SW-84-010) for public comment in two volumes. These two documents are available from NTIS and include the User's Guide for Version 1 and documentation and description of the program. The HELP Model (Version 1) is also available for the IBM PC/XT or compatible computers. Version 2 of the HELP Model is being developed to incorporate public comments and results from verification studies and will be published in late 1989. This document is identified as NTIS numbers PB 85-100840* and PB 85-100832.*

2.5 Lining of Waste Impoundment and Disposal Facilities

This document provides detailed information on flexible membrane liners (FMLs) and other materials used in the construction of containment facilities for the storage or disposal of hazardous and/or nonhazardous wastes. Various liner types are described in relation to their internal properties; criteria for manufacturing and selection as it relates to waste compatibility; and procedures for proper installation. These liners are used to control the release of liquid and gaseous components of the waste. The types and properties of wastes that may be impounded in land disposal facilities and the compatibility of these wastes to the materials are discussed. Several test methods used in determining waste/FML compatibility are also presented. A representative list of liner manufacturers and installers are presented as an appendix. This document is identified as NTIS number PB 89-129670.*

2.6 The Fabrication of Polyethylene FML Field Seams

This document is meant to summarize the numerous construction quality control and construction quality assurance (CQC and CQA) guidelines that are presently available for high density polyethylene (HDPE) liner installation and inspection. The current documents available to the installer allows almost complete freedom in making seams with the only condition being that they pass; (1) destructive shear and peel tests to a stipulated strength; and (2) selected nondestructive tests, e.g. vacuum box testing. However, there is a long-term concern regarding seam integrity which is not addressed by following this course of action. The long-term service life of HDPE liners is compromised when seams are made improperly. This comes about by overgrinding, overheating, placing new welds directly over older welds, or simply by poor workmanship. By developing a "standard-of-practice", document it is hoped that the above negative features of seam fabrication can be avoided. The manual is focused toward the use of three types of field seams for fabricating of seams in HDPE liners: (1) extrusion fillet seams (2) extrusion flat seams and (3) hot wedge seams. This document is expected to be available from NTIS in December, 1989.

2.7 Design, Construction, and Evaluation of Clay Liners for Waste Management Facilities

This document is a compilation of all of the available information on the design, construction, and evaluation of clay liners for waste landfills, surface impoundments, and waste piles. The information was obtained from the literature and from in-depth interviews with design and construction engineers and other knowledgeable individuals in both the private and government sectors. The broad topics covered in this document are: clays, with emphasis on their composition, fabric, and hydraulic conductivity; geotechnical test methods and soil properties including index properties, soil classification, and hydraulic conductivity testing; clay chemical compatibility, including a discussion on the mechanism of interaction and a comprehensive compilation of existing test data from the literature and private sources; construction and quality assurance; clay liner failure mechanisms; the performance of existing clay liners based on case studies of 17 sites; and clay liner transit time prediction methods featuring an in-depth discussion of many available techniques and models. This document is identified as NTIS number PB 89-181937.*

2.8 Batch Type Adsorption Procedures for Estimating Soil Attenuation of Chemicals

This document summarizes laboratory batch procedures for assessing the capacity of soils to attenuate chemical constituents from solutions such as leachates. It explains the scientific basis and rationale for these procedures and the use of data in designing soil liners for pollutant retention. This document has been revised to incorporate public comments and a publication date of November, 1989 is anticipated. The public comment draft is available from NTIS, number PB 87-146155.

2.9 Management of Hazardous Waste Leachate

This document has been prepared to provide guidance for permit officials and disposal site operators on available management options for collecting, treating, and disposing of hazardous waste leachates. It discusses considerations necessary to develop sound management plans for leachate generated at surface impoundments and landfills. Management may take the form of leachate collection and treatment or pretreatment of the wastes. This document is identified as NTIS number PB 81-189359.*

2.10 Guide to the Disposal of Chemically Stabilized and Solidified Wastes

The purpose of this document is to provide guidance in the use of chemical stabilization/solidification techniques for limiting hazards posed by toxic wastes in the environment, and to assist in the evaluation of permit applications related to this disposal technology. The document addresses the treatment of hazardous waste for disposal or long-term storage and surveys the current state and effectiveness of waste treatment technology. A summary of the major physical and chemical properties of treated wastes is presented. A listing of major suppliers of stabilization and solidification technology and a summary of each process is included. This document is being updated and revised and will evaluate, assess, and develop solidification/stabilization (S/S) technology for treating hazardous waste under land ban provisions of the Resource Conservation and Recovery Act (RCRA) of 1976, for closure of pits, ponds and lagoons and for remediating contaminated soils. This document is identified as NTIS number PB 87-154902.* The revised version is expected to be available from NTIS in October, 1990.

2.11 Guide to Technical Resources for the Design of Land Disposal Facilities

The purpose of this document is to direct permit applicants and permit application reviewers to EPA documents which may be helpful in answering specific technical questions which arise during permit application preparation and processing. Non-EPA technical literature has been included in this document as appropriate. The list of non-EPA documents for any one subject may not be all inclusive. The Guide does not provide detailed guidance on each regulatory standard for RCRA permit applicants but rather provides an overview of technical considerations. To maximize its usefulness as a Guide , emphasis has been placed on consistency. While the Guide generally does not discuss in detail the

information provided in the technical engineering reports, it directs the reader to the locations within these technical reports where specific subjects are addressed. The topics included in this Guide are limited to key performance standards and minimum technology requirements specified in 40 CFR Part 264 for hazardous waste landfills and surface impoundments. The topics include: (1) Foundations, (2) Dike Integrity and Slope Stability, (3) Liner Systems, (4) Cover Systems, and (5) Run-on/Run-off Controls. This document is expected to be available from NTIS in November, 1989.

2.12 Design, Construction, Operation and Closure of Hazardous Waste Surface Impoundments

This document will bring together the research and engineering information on the state-of-the-art in the design, construction, operation and closure of hazardous waste surface impoundments. Existing information is cited and summarized where appropriate. Attention is particularly given to engineering design with respect to dikes (slope stability), flexible membrane liners and soil liners that will meet the requirements of the RCRA regulations for surface impoundments. Current construction practices are described with emphasis on construction quality assurance and its importance in preventing leakage during later operation of the impoundment. Operation, maintenance, and monitoring activities are discussed. Ground-water monitoring is an important aspect of impoundment operation. The two acceptable closure methods, clean closure and in-place closure are described, along with post-closure monitoring activities. This document updates "Closure of Hazardous Waste Surface Impoundments," NTIS number PB 87-155537. The updated document is expected to be available from NTIS by December, 1989.

3. Technical Guidance Documents for Contaminated Sites

Nine (9) basic research programs have been established to date to investigate the release and control of pollutants from uncontrolled hazardous waste sites. These research programs are producing guidance documents for various control technologies. A listing of these research programs and resulting guidance documents which contain unique state-of-the-art information is shown below, along with a brief description and report/publication number.

3.1 *In Situ* Treatment Program

The research program on In Situ Technology is developing cost-effective technology for cleanup of uncontrolled hazardous waste (Superfund) sites. The major goals of this program are to: (1) develop engineering and situation assessment procedures that the Office of Solid Waste and Emergency Response (OSWER) and the Regional Offices can use for conducting Remedial Investigations/Feasibility Studies for Superfund sites; (2) evaluate the effectiveness, costs, and cross-media impacts of technologies that can be used in situ for treatment and control of contaminants at uncontrolled hazardous waste sites; (3) provide engineering technical support to enforcement, program, and regional offices on techniques/procedures for site and situation assessment and technologies for in situ management of hazardous waste sites; (4) identify, and develop to bench scale, concepts for *in situ* treatment that can be nurtured by

the Emerging Technology Program in the Superfund Technology Demonstration Division. An updated document entitled "Handbook on *In Situ* Treatment of Hazardous Waste Contaminated Soils," is expected to be available in January, 1990. The original document is a two volume report entitled, "Review of In-Place Treatment Techniques for Contaminated Surface Soils." This document presents information on in-place treatment technologies applicable to contaminated soils less than two feet in depth. Volume 1: Technical Evaluation and Volume 2: Background Information can be ordered from NTIS as number PB 85-123881* and PB 85-124899,* respectively.

3.2 Solidification/Stabilization Program for Treating Hazardous Waste

This program will evaluate, assess and develop solidification/stabilization (S/S) technology for treating hazardous waste under land ban provisions of the Resource Conservation and Recovery Act (RCRA) of 1976, for closure of pits, ponds and lagoons and for remediating contaminated soils. The laboratory-scale, pilot-scale, and field-scale research already conducted in previous studies of S/S technology will be continued in the areas of chemical interferences, basic binding mechanisms, and the evaluation of leaching protocol. Assessment of long-term criteria, use of organophilic clays for S/S of low level organic contamination, effects of soil properties on S/S and Quality Assurance and Quality Control (QA/QC) requirements. Cooperative efforts with Canada, ASTM and similar organizations will continue to develop protocols for evaluating S/S forms and development of performance predictive methodologies. The research being performed under this project will result in the revision of the current S/S document entitled, "Handbook for Stabilization/Solidification of Hazardous Waste." This updated document is expected to be available in October, 1990. The original handbook document provided guidance for the evaluation, selection, and use of solidification/stabilization technology as a remedial action alternative at uncontrolled hazardous waste sites. This document is identified as NTIS number PB 87-116745.*

3.3 Combustion Technologies Program

This program is evaluating thermal processes for destroying hazardous contaminants contained in soils at uncontrolled hazardous waste sites. One of the methods being used to evaluate thermal processes is the shipping of samples from Superfund sites by Regional Offices to the Risk Reduction Engineering Laboratory (RREL) Incineration Research Facility (IRF) in Arkansas to evaluate thermal processes for destroying the contaminants and cleaning the soil. In addition, combustion tests will be conducted on synthetic matrices that are representative of problems dealing with contaminated soils. Operation of the IRF will be supported and a data base on combustion results with various wastes and combustion variables will be gathered. The data gathered from this project will result in a document entitled, "Results of Combustion of SARA Wastes at IRF," is expected to be available from NTIS in September, 1990.

3.4 Best Demonstrated Available Technology (BDAT) Program

This program will provide performance data for soil treatment technologies that will be used at Superfund sites. Several technologies are being evaluated to

obtain data on performance: solidification/stabilization methods for inorganic wastes; low temperature thermal treatment of volatile organic compounds; the potassium polyethylene glycol (KPEG) process for certain contaminated soils; and soils washing for volume reduction of organic or inorganic contaminants. Additional treatment technologies will be evaluated to determine their relative importance to soil and debris cleanup. Technologies will be evaluated at bench-scale, or full-scale soil remediations. A document entitled, "Alternative Treatment Technology Evaluations of Superfund Soils and Debris," is expected to be available from NTIS in February, 1990.

3.5 On-Site Treatment Technologies Program

This program will provide technology to support emergency and remedial response at uncontrolled hazardous waste sites. Both mobile cleanup equipment and on-site technologies will be developed for use at uncontrolled hazardous waste sites. Such systems will typically be flow-through types of processes utilizing physical, chemical, or biological means to extract, degrade, detoxify or immobilize contaminants at a Superfund site. Technologies showing potential for commercialization will be transferred to the Superfund Innovative Technology Evaluation (SITE) Program for full-scale field evaluation. A document entitled, "Handbook on On-Site Cleaning Equipment," is expected to be available from NTIS in July, 1990.

3.6 Emerging Biosystems Program

This program is evaluating, developing, and demonstrating emerging biosystems for the detoxification and/or destruction of hazardous wastes at Superfund sites. Evaluation and demonstration of biosystems will be achieved through a balanced research program utilizing both in-house and extramural capabilities (facilities and personnel). The evaluation of new or proprietary strains of microorganisms for suitable application to waste treatment at Superfund sites will be explored. This evaluation will include comparison with conventional methodology, the use of multiple unit operations to treat complex waste mixtures, engineering scale up and process evaluation, specific data needs and methods for evaluation and field verification of developed technology. Studies will be conducted on the control of releases from biosystems which could cause adverse impacts. The scope of treatment types to be developed will range from *in situ* to specific reactor developments for the treatment of soils, sludges, and aqueous wastes, including leachates and pumped groundwaters. A document entitled, "Biochemistry and Genetics of Polychlorinated Biphenyl Degradation by Bacteria," is expected to be available from NTIS in June, 1990.

3.7 Expert Systems Program

This program is developing microcomputer-based decision support tools (expert systems) to address commonly encountered waste management issues. The technology used to develop these decision aides is commonly known as expert systems. The expert system is an automated process which incorporates the judgement, experience, rules of thumb, and intuition used by a human specialist to emulate that specialist's problem solving abilities. The objective of these systems is to furnish the same recommendations concerning particular decision scenarios as

would an authority in the field. EPA's Risk Reduction Engineering Laboratory (RREL) has been active in development of expert systems to aid hazardous waste managers. As a result of this effort, two tools have been developed, more are scheduled for completion this year, and others are in the beginning stages of development. The six systems being developed so far are: (1) the "Flexible Membrane Liner System" (FLEX), an advisory system to assist in the analysis of chemical compatibility data for flexible membrane liners. EPA specifies that geosynthetics which are used in hazardous waste containment applications must first be tested for compatibility with leachate from the contained substances. This system was completed in November of 1988 and is currently undergoing beta testing in selected EPA offices prior to formal release; (2) the GM system is a geosynthetic modelling advisor. It contains knowledge concerning the appropriate engineering calculations used in geotechnical designs which incorporate geosynthetic components. Scheduled for completion this year; (3) the "Waste Analysis Plan Section of RCRA" (WAPRA) system assists in the review of the RCRA Part B facility permit applications. This system is scheduled for completion in June, 1989; (4) Leachate Collection System Advisor system analyzes the suitability of a leachate collection system based upon various site characteristics and design parameters. Development of this system is ongoing with a tentative completion date of June, 1989; (5) the VEGCOVER system contains knowledge concerning the suitability of plant species proposed for use in the vegetative cover layer of landfill and surface impoundment caps. Development is ongoing with a completion date of September, 1989; and (6) TECHSCRN advises the user of the technical feasibility of various remediation alternatives for Superfund sites. A completion date has not been identified.

3.8 Personnel Health Protective Equipment Program

This program is evaluating and assessing technology to ensure personnel health and safety during removal and cleanup operations, including the evaluation and assessment of: personal coolers, protective clothing, breathing apparatus, personal monitoring for exposure, procedures for site operations, and decontamination procedures for protective clothing exposed to hazardous materials. Increasing the protection and maximizing the time one can work at the site, then removal and/or remedial actions can proceed safely in a more cost-effective manner are some of the project goals. Project findings have been discussed via reports, oral presentation, journal articles, and workshops. A document entitled, "Evaluation and Improvement of Protective Clothing, Equipment, and Procedures for Hazardous Substances Responsible Operator," is expected to be available from NTIS in October, 1990.

3.9 Site and Situation Assessment Program

This program will provide engineering support for Superfund site and situation assessments including, remedial action evaluations of engineering costs, waste characteristics, hydrology, geology and soil characteristics. Staff members will serve on technical advisory committees, review assessment and feasibility plans and advise on remedial actions. Based on data collected from surveys and technology evaluations, the information on the cost and effectiveness of remedial action technologies will be provided for specific sites and in general remedial investigations/feasibility studies (RI/FS) technical guidances. Increased emphasis will be placed on the development of support tools such as expert

systems, to assist RI/FS activities. A document entitled, "Optimization of Treatment Options for Superfund Remedial Actions," will be available from NTIS in January, 1991. Previous Guidance Documents published in this area are: "Handbook: Remedial Action at Waste Disposal Sites (Revised)," NTIS number PB 87-201034; "Covers for Uncontrolled Hazardous Waste Sites," NTIS number PB 87-119483 and "Slurry Trench Construction for Pollution Migration Control," NTIS number PB 84-177831.

4. Conclusion

The Technical Guidance Documents that are being prepared and updated are a series of documents which provide best engineering control technology to meet the needs of RCRA and CERCLA, respectively. More information about a specific document and/or program can be obtained by writing or telephoning the U.S.EPA, Risk Reduction Engineering Laboratory, 26 W. Martin Luther King Drive, Cincinnati, Ohio 45268. Phone (513) 569-7871.

*Documents can be purchased from NTIS by requesting the (PB) number:

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